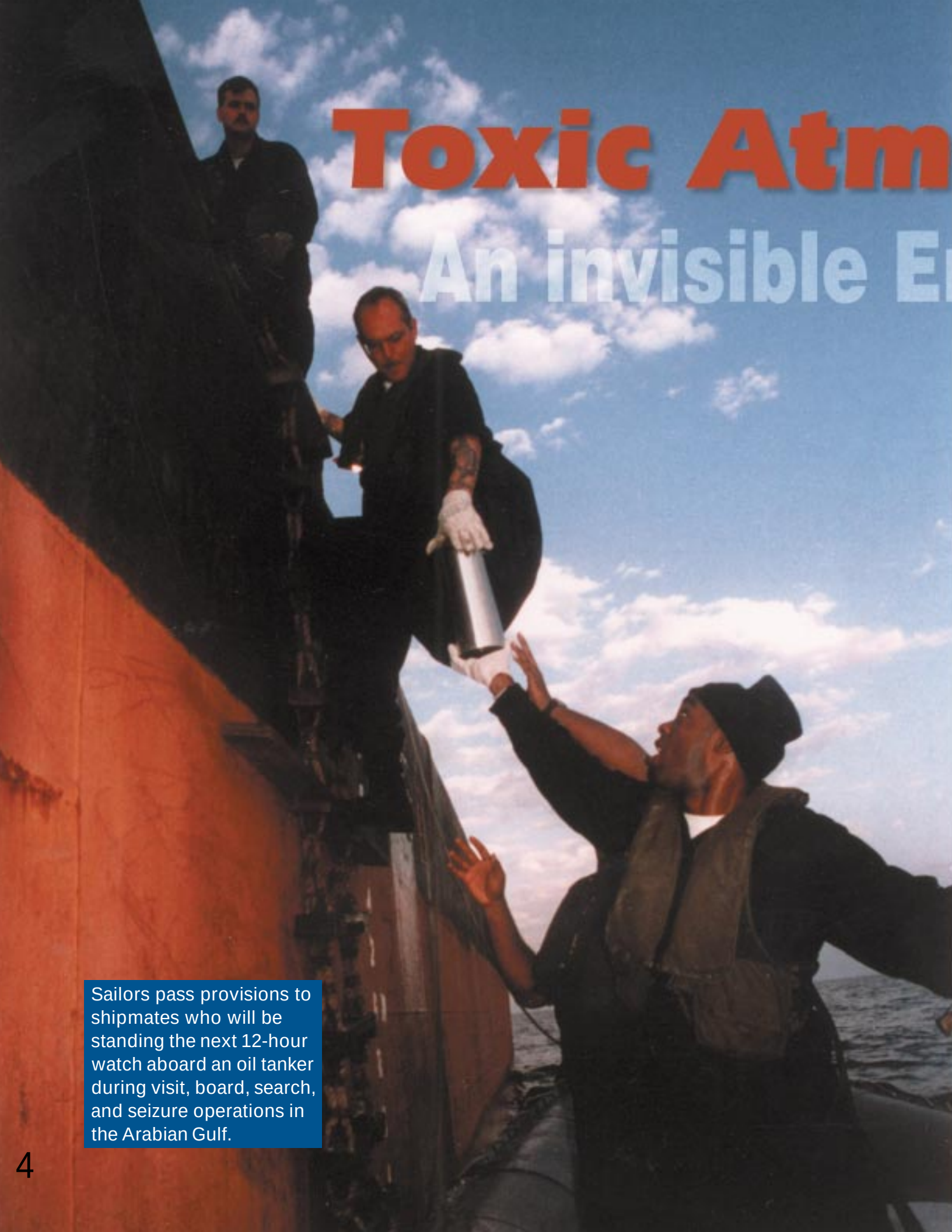


Sailors pass provisions to shipmates who will be standing the next 12-hour watch aboard an oil tanker during visit, board, search, and seizure operations in the Arabian Gulf.

ospheres:

nemy (A Primer for Boarding Teams)

By Mike Anderson

A boarding team approaches the cargo hold of a small fishing vessel. The team spots two men, face down, on a pile of fish and ice. A third man, apparently trying to rescue the first two, lies motionless at the bottom of a ladder. The boarding team recalls a training video on the danger of confined-space atmospheres, evacuates the space, and reports the finding to their ship. No one knows the exact cause of the three fishermen's deaths, but training prevents the boarding team from also becoming casualties.

This situation, confronted by a Coast Guard boarding team off the coast of Florida, underscores the importance of gas-free training for all boarding teams. Since the 1990s, Navy ships have supported United Nations sanctions and the war on drugs by conducting visit, board, search, and seizure (VBSS) operations in the Arabian Gulf, the Red Sea, the Adriatic, and the Caribbean. Although boardings have become routine, boarding-team members cannot afford to relax because of the severe risks they face.

The boarding team aboard your ship probably is well-trained and equipped to face the risks posed by potentially belligerent crews, but are they trained and equipped to face the invisible enemy—toxic atmospheres? Here are some training tips that will increase your boarding team's awareness and maybe even save a life.

Apply operational risk management (ORM).

When a boarding party crosses over a set of lifelines, they leave behind a ship engineered for safety and climb aboard a vessel economized for profits. A Sailor aboard a Navy ship is protected from toxic atmospheres by a layered defense that includes design controls, such as ventilation; administrative controls, such as confined-space, entry-permit procedures; a vast stock of protective clothing and respiratory equipment; and multiple layers of supervision.

In contrast, the ship a Sailor boards may be in great disrepair, with shoddy ladders, loose deckplates, rusting compartments, sloshing bilges, exhaust-filled machinery spaces, exposed wires, unregulated hazmat, and holds full of shifting cargo emitting unknown vapors in the sweltering heat. Moreover, boarding-team members are dressed out with Kevlar and a sidearm and are more focused on the security threat posed by crewmen. The sweep team's priority is to inspect the vessel rapidly and thoroughly for any contraband. Their search will take them to every corner of the vessel, and the most suspicious spaces often are the most dangerous.

The challenge in this risky environment is to keep the team safe without adding baggage, time constraints, or additional people. It would take a massive publication to lay out requirements for confronting each type of hazard during boardings, and more manuals are not the answer. The common-sense solutions lie in applying ORM, which involves a thought process that maximizes safety while maintaining operational flexibility.

The first step of this process is to assess the level of risk. Because a confined-space injury to a boarding-team member is likely over time, the risk must be assessed as serious. This risk is inherent to accomplishing the mission of maritime interdiction. However, boarding teams do not need to take any unnecessary risks. Risks should be minimized through training and planning, which requires famil-

iarity with the hazards, the ability to detect them, and a methodology for making informed decisions to handle the hazards.

One tool of risk management is to use protective equipment. In the past few years, Navy ships have been equipped with excellent gas-detection equipment, such as the Biosystems PhD Ultra 4 gas analyzer. They also have excellent breathing devices, such as the MSA supplied-air respirator, with a backup self-contained breathing apparatus (SCBA). For ventilating confined spaces, Navy ships typically use a firemain, pressure-driven RamFan 2000, with elephant trunks. Protective clothing, such as Tyvek coveralls and rubber gloves, can protect Sailors from developing occupational dermatitis or from absorbing toxic hazards (such as fuels) through their skin.

Boarding teams should be trained to use gas-detection equipment for identifying potential hazards, ventilation equipment for making a hazardous atmosphere safe, and respiratory equipment and protective gear for making the team members safe for entering potentially hazardous spaces. These items don't have to be added to the boarding kit. Boarding teams can protect themselves by assigning the Ultra 4 gas analyzer to a sweep-team member and calling for safety gear from the ship as needed.

Be aware of the common hazards aboard merchant vessels.

The National Institute for Occupational Safety and Health has established recommended exposure limits for more than 400 potentially lethal toxic substances that may exist in a shipboard environment. Correlating every item on a cargo manifest with a potential toxic hazard, however, would be a phenomenal undertaking. Advances in technology are simplifying this task, such as photo-ionization

Navy photo by PH2(AW) Gloria J. Barry

Sailors count the contents of a ship's cargo bays during a security sweep, as part of VBSS operations in the Northern Arabian Gulf.

detectors used by civilian industry to sense literally hundreds of toxic substances with a detector the size of a cigarette lighter. While such equipment is still far too costly, the good news is that Navy ships already have a portable detector that can detect the major threats and indicate the likely presence of any other threats.

The major hazards responsible for most deaths in confined spaces are oxygen deficiency, hydrogen sulfide, carbon monoxide, and other explosive gases, in that order. The Navy already has equipped all ships with Ultra 4 gas analyzers that detect the level of oxygen, explosive gases, carbon monoxide, and hydrogen sulfide, which makes them ideal for use during boardings.

Here are some potential hazards a boarding team may encounter aboard merchant vessels:

• Spaces containing organic materials that can rot, such as fruits, vegetables, fish, sugar, sewage, sour crude oil, marijuana, and grains or natural fiber lines. These materials will deplete oxygen and further deteriorate into hydrogen sulfide and, possibly, methane.

• Standing seawater, which will support organisms that deplete oxygen and produce hydrogen sulfide.

• Rust, which depletes oxygen and generates hydrogen gas.

• Fresh paint or spaces that have been painted and immediately closed. These conditions can cause oxygen deficiency, may indicate a presence of carbon monoxide, and may retain explosive vapors.

• Fuel vapor, fuel residue, cleaning solvents, coatings, acetylene and propane. These substances may create explosive atmospheres. Also, fuels and solvents may displace oxygen with hydrocarbons.

• Inefficient gas and diesel engines, trapped exhaust gases, and dewatering pumps, which can produce dangerous levels of carbon monoxide.

• Various bacteria, which can metabolize and then ferment wastes, releasing deadly levels of carbon dioxide and nitrogen into a confined space, while displacing oxygen.

• Inert gas, which can wreak havoc on a boarding team. Any ruthless smuggler can intentionally fill a space with an inert gas or run eductors to deplete oxygen, while denying direct responsibility.

Boarding teams can be prepared to identify the endless varieties of hazmat vessels may carry and even perform first aid with the help of one small guidebook: the Hazardous Material Users Guide (HMUG). This small handbook is found in hazmat-spill kits and also is available on the hazardous material information system (HMIS) CD-ROM distributed to all Navy ships every quarter.

"Red flag" potentially hazardous spaces.

Boarding teams should not take any unnecessary risks. Security teams and sweep teams should identify any questionable risk as a "red flag" and report it to the boarding officer for a decision on how to proceed safely. Before entering a cargo hold or other confined area, sample the atmosphere with an Ultra 4 gas analyzer. Specified readings should halt entry into that particular space until the boarding officer determines a safe way to proceed or categorizes the space as inaccessible. Here are some items that should send up a "red flag" anytime you find them:

• A space with an oxygen reading below 20.8 percent. Some unknown hazard has depleted or displaced the oxygen in that space.

• A lower-explosive-limit (LEL) reading above zero. Such a reading indicates the presence of a flammable gas that may also be toxic.

• A carbon-monoxide level above zero. Such a level indicates the presence of a flammable and toxic source (such as machinery exhaust).

• A hydrogen-sulfide level above zero. Such a level indicates a source of anaerobic decay (such as rotting matter).

• Refusal of a crew escort to enter a space before the boarding team. His refusal may indicate the intentional or known presence of hazards.

• Unusual odors or signs of mist or smoke. These items may indicate the presence of toxic substances.

If a boarding team is going to use only an Ultra 4, gas-analyzer drop test to assess the level of risk for space entry, they should be trained to follow a very conservative guideline. Instead of applying the shipboard "safe for personnel" guidelines (oxygen between 19.5 and 22 percent, LEL less than 10 percent, carbon monoxide less than 50 ppm, and hydrogen sulfide less than 10 ppm), they should be concerned about any indication of a hazardous gas presence and "red flag" the space.

A sweep team can "red flag" a space by reporting conditions to the boarding officer and requesting respiratory equipment. The sweep team then could move on to other spaces until they receive permission to enter the first space and don the correct respiratory protection.

A "red flag" introduces an intentional pause into sweep-team procedures, letting decision-makers assess the risk and prescribe safety measures (controls) before entering a space. This action would prevent an over-zealous member from rushing into a hazardous atmosphere, becoming incapacitated, and jeopardizing the entire team by throwing them into a victim-rescue mode during a boarding.

Understand the danger of oxygen displacement.

At sea, a normal oxygen reading is 20.8 percent. At less than 19.5 percent oxygen, a space is considered immediately dangerous to life and health (IDLH). However, a boarding team should be aware that the reason oxygen levels fall below 20.8 percent is because something depletes or displaces the oxygen. In the case of oxygen displacement, the decrease is proportional to the increase in the concentration of a potentially toxic or explosive gas. If a boarding team is using an Ultra 4 gas analyzer, they will be unable to determine the exact cause of oxygen displacement, and they should consider any space containing less than 20.8 percent oxygen as potentially hazardous and "red flag" it.

Understand how any presence of flammables may correlate to dangerous levels of toxic gas.

The sweep-team member operating an Ultra 4 gas analyzer is able to monitor flammables as a percent of LEL. Any level above 10 percent of the LEL is considered IDLH because of the risk of fire or explosion. Also, any presence of a flammable above zero percent LEL could correlate to a deadly level of toxic gases.

Many gases reach high toxic levels—even above the IDLH limits—at flammable levels as low as 1 percent LEL. Consequently, a boarding team can apply the LEL reading on an Ultra 4 gas analyzer as an indicator of hidden toxic gases, which is especially helpful when a sweep team encounters dangerous hydrocarbons, such as fuel vapors, cleaning solvents, or paints. Any LEL above zero would indicate potentially flammable or toxic atmospheres. The team then should "red flag" the space, report the conditions to the boarding officer, recommend respiratory protection, and wait for permission to enter. Follow-up tests can be done with Draeger tubes to check for hydrocarbons or other chemicals. In the meantime, the sweep team can move to other spaces.

Do alternative searches for IDLH and inaccessible spaces.

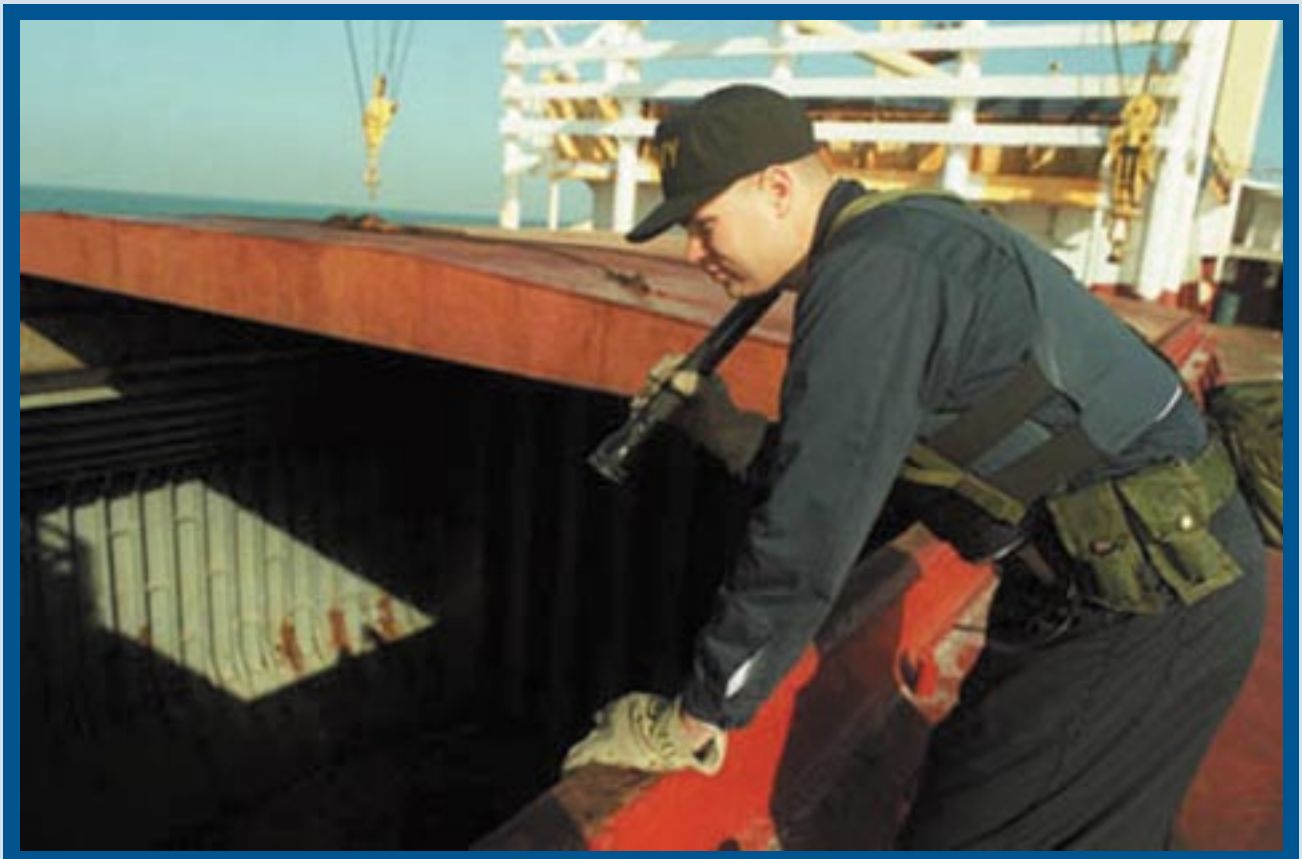
As a sweep team passes a sewage tank, they notice the cover is open slightly. There, sticking out of the corner, is a plastic bag containing hurriedly concealed contraband.

Boarding teams may find the clever use of false compartments and IDLH spaces (such as sewage and fuel tanks) to conceal smuggled contraband. Such spaces are intentionally selected because they are confined, inaccessible, unventilated, and uninhabitable. If a sweep team suspects they have found such a space, they should "red flag" it by telling the boarding officer and asking for further guidance. A boarding team needs to realize that "only fools rush in" and that the command has alternative ways to gather evidence.

The boarding officer should explore safe options with the CO. The boarding officer may find evidence of contraband hidden in tanks without even opening them. For example, there may be discrepancies in a ship's documents, such as tank soundings not meshing with levels of consumption. Also, the boarding officer may find that the vessel is not complying with the requirement for making all cargo accessible. Inaccessibility of cargo (due to height of load, method of loading, or intentional obstruction) may prevent further inspection of a vessel, and it might present a violation that calls for the vessel to be detained at anchor. Depending on the situation, the CO may pursue any of these options:

- Declaring the space inaccessible and holding the vessel's crew responsible for bringing the cargo out into the open.
- Directing the vessel to anchor. The boarding team then may inspect the vessel under less rushed

Navy photo by PH2(AW) Gloria J. Barry



A Sailor inspects a cargo hold aboard an Iranian merchant ship for contraband during visit, board, search, and seizure operations.

conditions. If necessary, they can ventilate a space, don safety gear, brief the event, and station standby rescuers.

• Divert the vessel to a port for dockside inspection. This option may involve shore-based inspectors.

Although some boarding teams may feel an overwhelming sense of urgency to access a confined space to retrieve concealed evidence (and may even express complete willingness to heroically bolt into the space unprotected), such reaction needs to be reigned in. The team should be trained to avoid rash action by reporting a "red flag" and intentionally breaking the momentum of an inspection. Teams should remember that a command has alternatives, and the best choice may include inspecting the space at a later time.

Never stop holding training.

All safety programs rely on training as the means of preventing mishaps. The shipboard gas-free engineer can help train boarding teams by addressing these subjects:

- Use of gas-free detection equipment
- How to rig exhaust ventilation
- Use of supplied-air respirators
- Toxic absorption and use of PPE
- Hazmat and using the HMUG
- Confined-space rescue and toxic-gas victim drills
- Use of "red flag" decision trees.

Mr. (formerly Lt.) Anderson was the leading gas-free engineering instructor for DCA students at the Surface Warfare Officer School Command in Newport, R.I., when he wrote this article. He previously served as DCA aboard USS David R. Ray *(DD 971), and during three years as a gas-free engineer, boarded more than 25 vessels in the Arabian Gulf.*